Advanced Energetic Materials for Agent Defeat: Impact-Driven Reactions in Biocidal Reactive Materials for WMD Applications

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Advanced Energetic Materials for Agent Defeat: Impact-Driven Reactions in Biocidal Reactive Materials for Weapons of Mass Destruction (WMD) Applications

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Abstract—Dynamic thermite reactions can produce iodine or silver gas, which may destroy spore-forming bacteria. Initial experiments have demonstrated reaction rates up to 1300 m/s and fireballs exceeding 1000 ˚C.

1 Objectives

The objectives of the proposed efforts remain as follows: (1) to understand the reaction kinetics of materials that generate biocidal gases, and (2) to understand the way spore-forming bacteria respond when exposed to impact-generated biocidal gases and nanoparticulate metal oxide reaction products.

2 Status

Initial impact experiments performed with a surrogate, bismuth trioxide, have shown very significant thermobaric effects that are absent in an inert atmosphere. New instrumentation to measure transient pressure and temperature has been developed. Given successful results in another program with impact reaction at velocities of 1000 m/s and lower, it was decided to perform initial experiments on this program at lower velocities. This results in a large cost savings for launch-related expenses, so the investigators plan to expand the effort at spectroscopic analysis of reaction products to better define reaction kinetics. Initial tests are being set up using absorption spectroscopy. The initial biological experiments will be based on a kill/no kill criterion, using B. subtilis spores. The protocols for the biological tests are being written. An apparatus has been constructed to perform biologic studies with combustion-ignition of chemicals. Initial differential thermal analysis (DTA) tests have identified optimum equivalence ratios for silver oxide–aluminum mixtures. The combustion apparatus will be used for the initial biological experiments.

3 Accomplishments and Findings

The hot alumina particles produced by impact-driven reactions result in > 1000 ˚C fireballs. These are absent in inert atmosphere tests. Thus, the atmosphere and amount of excess aluminum are important variables to consider in future tests.

Basic characterization tests have been performed on the combustion of two biocidal thermites. Al+AgO and Al+I_2O_5 have been shown to self propagate at speeds up to 1300 m/s in confined burning configurations. Pressurization rate measurements indicate significant convective burning, which will aid in the dispersion and exposure of biocidal product gases to spore forming bacteria. Reaction diagnostics are currently being assembled. Figure 1 shows flame front propagation, and Figure 2 is a schematic diagram of the biocidal chamber.

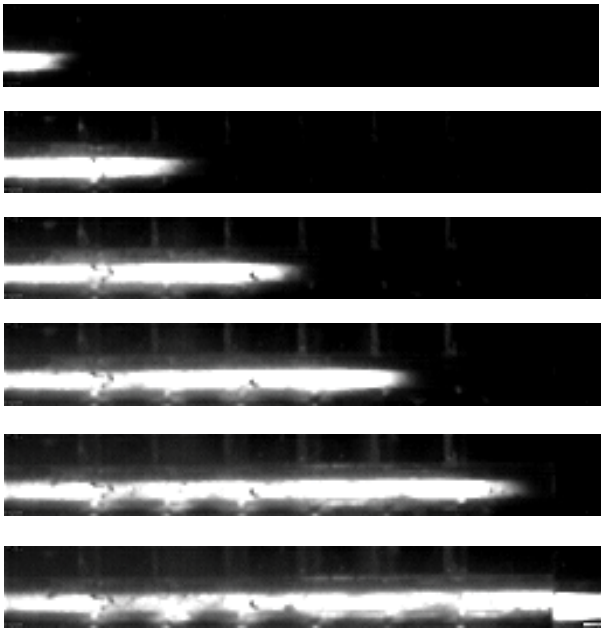

Figure 1. Al+AgO 1305 m/s, Al+I_2O_5 532 m/s.

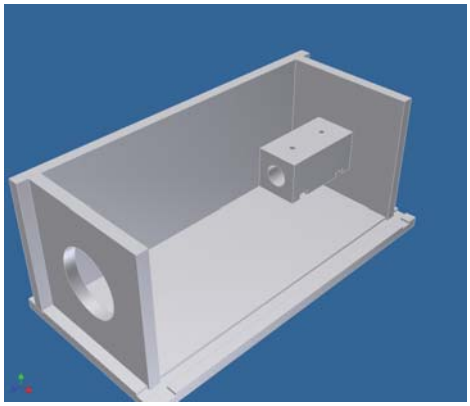

Figure 2. Biocidal chamber.

4 Personnel Supported

At the Institute for Advanced Technology (IAT), this project has supported Dr. Stephan Bless (PI), Mr. Rod Russell (research engineer), Ms. Tiffany Chen (undergraduate student), and technicians in the impact laboratory. At Texas Tech University, the program has supported Dr. Michelle Pantoya (co-PI) and William Clark (graduate student).

5 Publications

There have been no publications during the subject reporting period.

6 Interactions/Transitions

Dr. Bless and Mr. Russell visited the Army Research Laboratory, Aberdeen, MD, on June 26, 2008, and exchanged ideas with the staff in the Propulsion Technology Branch on how to characterize impact-driven exothermic reactions. Mr. Russell presented a seminar on IAT efforts, which included some results from the present contract.

7 Inventions

There were no inventions during the subject reporting period.

8 Honors, Degrees, Etc.

There were no awards or degrees received related to this contract during the subject reporting period.